Claims

1. A device comprising:

a nanotube having a substantially cylindrical wall, having a diameter that is less than one micron and a length measured in a direction perpendicular to the diameter; and

a magnetic nanoparticle that is attached to the nanotube and not encircled by the wall, the magnetic nanoparticle having a longest dimension that is less than one micron.

2. The device of claim 1, further comprising a plurality of magnetic nanoparticles that are attached to the nanotube and not encircled by the wall.

3. The device of claim 2, wherein the magnetic nanoparticles are superparamagnetic.

4. The device of claim 1, wherein the nanoparticle contains an element selected from the group consisting of cobalt, nickel and iron.

5. The device of claim 1, wherein the nanoparticle is attached to the nanotube by an electrostatic or hydrophobic interaction with a carbonyl, carboxyl, hydroxyl or sulfate functional group.

6. A method comprising:

providing a plurality of nanotubes, the nanotubes each having a substantially cylindrical wall, having a submicron diameter and a length measured in a direction perpendicular to the diameter, the length being greater than the diameter; and

attaching a plurality magnetic nanoparticles to each of the nanotubes, the nanoparticles each having a longest dimension that is less than one micron, such that each of the nanoparticles is not encircled by the wall.

7. The method of claim 6, wherein attaching a plurality magnetic nanoparticles to each of the nanotubes is by electrostatic or hydrophobic interaction with a carbonyl, carboxyl, hydroxyl or sulfate functional group.

8. A method comprising:

providing a plurality of nanotubes, the nanotubes each having a substantially cylindrical wall, having a submicron diameter and a length measured in a direction perpendicular to the diameter, the length being greater than the diameter;

aligning the nanotubes on a grid having a plurality of metal grid lines; and

removing a portion of each of the nanotubes that are disposed between the grid lines.

9. The method of claim 8, wherein aligning the nanotubes on the grid includes positioning the nanotubes on the grid with a magnetic force.

10. The method of claim 8, wherein aligning the nanotubes on the grid includes scanning a row of sharp tips over the grid.

11. The method of claim 8, wherein removing the portion of each of the nanotubes includes applying an electric current to the grid.

12. The method of claim 8, wherein removing the portion of each of the nanotubes includes etching the nanotube portions with the grid as an etching mask.

13. A method comprising:

providing a plurality of nanotubes, the nanotubes each having a substantially cylindrical wall having a submicron diameter and a length measured in a direction perpendicular to the diameter, the length being greater than the diameter;

providing a filtration apparatus; and

filtering the nanotubes by the filtration apparatus according to the length of each of the nanotubes.

14. The method of claim 13, wherein the filtering includes applying a nonuniform magnetic field to the nanotubes in the filtration apparatus.

15. The method of claim 13, wherein the filtering includes applying an electric field to the nanotubes in the filtration apparatus.

16. The method of claim 13, wherein the filtering includes spinning the nanotubes in the filtration apparatus.

17. The method of claim 13, further comprising dispersing the nanotubes in a chemical and thereby forming a colloidal solution.

18. A method comprising:

providing a plurality of nanotubes each having at least one attached nanoparticle including a magnetic element, the nanotubes each having a substantially cylindrical wall, having a submicron diameter and a length measured in a direction perpendicular to the diameter, the length being greater than the diameter;

dispersing the nanotubes in a solution;

dispensing the solution on a wafer; and

arranging the nanotubes on the wafer by providing magnetic fields that interact with the magnetic elements of the nanoparticles.

19. The method of claim 18, wherein the solution is dispensed onto the wafer by spin coating.

20. The method of claim 18, further comprising patterning the wafer with magnetic regions.

21. The method of claim 18, further comprising magnetizing the magnetic elements with a magnetic field.

22. A transistor comprising:

a source;

a drain;

a gate;

a channel, the channel including a nanotube having a substantially cylindrical wall, wherein the nanotube has a submicron diameter and an elongate dimension that is substantially perpendicular to the diameter, and the nanotube is disposed between the source and the drain; and is substantially aligned along the shortest distance between the source and the drain.

23. The transistor of claim 22, wherein the transistor is fabricated by at least one of the methods of claims 6 through claim 21, inclusive.

24. A sensor device for detecting biological or chemical molecules comprising:

a plurality of conductive electrodes;

a single or plurality of nanotube channels connecting the electrodes, wherein the nanotubes having substantially cylindrical wall are substantially aligned with each other and with respect to the edges of the electrodes.

25. The sensor device of claim 24, wherein the nanotube channels are fabricated by at least one of the methods of claims 6 through claim 21, inclusive.

26. An electronic apparatus comprising

a plurality of electronic devices; and

a plurality of conductive interconnects that are connected between the electronic devices, each of the conductive interconnects including a nanotube having a substantially cylindrical wall, having a submicron diameter and a length measured in a direction perpendicular to the diameter, the length being greater than the diameter;

27. The electronic apparatus of claim 26, wherein the conductive interconnects are fabricated by at least one of the methods of claims 6 through claim 21, inclusive.

28. The electronic apparatus of claim 26, wherein the electronic devices include a magnetic random access memory (MRAM) cell, and the conductive interconnects are fabricated by at least one of the methods of claim 6 through claim 21, inclusive.